

PATENT ABSTRACTS OF JAPAN

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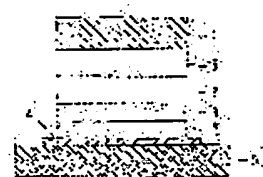
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(54) LIGHT EMITTING DEVICE, AND IMAGE DISPLAY DEVICE, LIGHT SOURCE, AND PHOTSENSITIVE EXPOSURE LIGHT SOURCE USING THE SAME

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a phosphorescence light emitting device having a light emitting layer formed of a single light emitting material.

SOLUTION: The light emitting device comprises an exciplex suppression layer 8 arranged between a light emitting layer 2 and a positive electrode 4. The HOMO level of the phosphorescent luminescent metal coordination compound is -5.5 ev or less, and the difference between the HOMO level of the exciplex suppression layer 8 and the HOMO level of the phosphorescent luminous metal coordination compound is 0.5 ev or less.



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CLAIMS

[Claim(s)]

[Claim 1]

In the light emitting device which has the organic luminous layer which is arranged between an anode plate, cathode, and said anode plate and said cathode, and consists only of a phosphorescence luminescence metal coordination compound,

It has the exciplex control layer arranged between said organic luminous layers and said anode plates, the HOMO level of said phosphorescence luminescence metal coordination compound -5.5eV or less -- it is -- and The light emitting device characterized by the difference of the HOMO level of said exciplex control layer and the HOMO level of said phosphorescence luminescence metal coordination compound being less than 0.5eV.

[Claim 2]

The central metal of said phosphorescence luminescence metal coordination compound is a light emitting device according to claim 1 characterized by being a rhenium.

[Claim 3]

The image display device which has a light emitting device according to claim 1 as a pixel of the image display section.

[Claim 4]

The light source which has a light emitting device according to claim 1.

[Claim 5]

The photo conductor exposure light source of the electrophotography type image formation equipment which has a light emitting device according to claim 1 as the light source.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[Field of the Invention]

[0001]

This invention relates to the light emitting device which has the organic luminous layer which is arranged an anode plate, cathode, and in the meantime, and consists only of a phosphorescence luminescence metal coordination compound. Furthermore, it is related with the image display device using this light emitting device, the light source, and the photo conductor exposure light source.

[Background of the Invention]

[0002]

An organic electroluminescent element (organic EL device) is a light emitting device. Research of an organic EL device is done energetically (nonpatent literature 1).

[0003]

Moreover, the examination using phosphorescence luminescence which went via the triplet exciton of a component is made (nonpatent literature 2 thru/or 3 and the patent reference 1 thru/or 3).

[0004]

Moreover, there are some which indicated constituting a luminous layer from two sorts of ingredients, such as a host and a guest, in the examination using phosphorescence luminescence which went via the triplet exciton of a component. this -- the energy transfer between two kinds of luminescent material -- using -- the long wave from the luminescent material (green luminescence) of short wavelength -- energy is moved to merit's luminescent material (yellow or red luminescence) -- making -- a long wave -- only merit's luminescent material is made to emit light (nonpatent literature 4)

[0005]

Moreover, there is also an announcement about the organic EL device by the single ingredient (phosphorescence luminescent material). This is a phosphorescence light emitting device using an iridium complex, it is the configuration of having prepared the hole blocking layer in the cathode side of a luminous layer, and it is thought that luminescence is performed by the electronic transporting bed side of a luminous layer from this (nonpatent literature 5).

[0006]

And the phosphorescence light emitting device which used the rhenium complex for the luminous layer is announced, and according to this, the hole transporting bed is arranged between the luminous layer and the anode plate. This hole transporting bed functions as an electronic blocking layer. And the difference of EL spectrum of this light emitting device and PL spectrum is 10nm (nonpatent literature 6).

[0007]

[Patent reference 1] JP,11-329739,A

[Patent reference 2] JP,11-256148,A

[Patent reference 3] JP,8-319482,A

[Nonpatent literature 1] Macromol.Symp.125, 1-48 (1997)

[Nonpatent literature 2] D. F.O' brei ens (Brien), "improved energy transfer Inn electro FOSUFORE cent device (Improved energy transfer in electrophosphorescent device)" "applied physics Letters (Applied Physics Letters), 1999,

Vol.74, No.3, p422"

[Nonpatent literature 3] M.A. Bardot et al. (Baldo), "Bury Hy-efficiency Green organic light-emitting DEBAISEZU based-on electro FOSUFORE sense () [Very high-efficiency green organic] light-emitting devices basd on electrophosphorescence" "applied physics Letters (Applied Physics Letters)" 1999, Vol.75, No.1, p.4

[Nonpatent literature 4] Yoshiharu Sato, "the ingredient-side face of a triplet component" (challenge to the Japan Society of Applied Physics, an organic molecule and a bioelectronics subcommittee, the 9th school, and next-generation organic electroluminescence)

[Nonpatent literature 5] IDW'02 NHK OELp-17 1207-1209

[Nonpatent literature 6] Inorg.Chem.2002,41,3353-3358

[Description of the Invention]

[Problem(s) to be Solved by the Invention]

[0008]

The phosphorescence light emitting device by which a luminous layer is constituted from a host and a guest will become high in respect of costs, such as the manufacture top productivity. Moreover, in the case of a component the luminous layer is indicated to be by nonpatent literature 6, the difference of EL spectrum and PL spectrum is not made to below fixed.

[0009]

The technical problem of this invention is ** for offering the light emitting device as for which has the luminous layer of the single ingredient which does not depend on the luminous layer of a host guest mold, and the difference of EL spectrum and PL spectrum is made to below fixed.

[Means for Solving the Problem]

[0010]

This invention,

In the light emitting device which has the organic luminous layer which is arranged between an anode plate, cathode, and said anode plate and said cathode, and consists only of a phosphorescence luminescence metal coordination compound,

It has the exciplex control layer arranged between said organic luminous layers and said anode plates, the HOMO level of said phosphorescence luminescence metal coordination compound -5.5eV or less -- it is -- and The light emitting device characterized by the difference of the HOMO level of said exciplex control layer and the HOMO level of said phosphorescence luminescence metal coordination compound being less than 0.5eV is offered.

[Effect of the Invention]

[0011]

By this invention, the phosphorescence light emitting device which sets the difference of EL spectrum and PL spectrum to less than 10nm and which a luminous layer becomes from a single ingredient can be offered.

[Best Mode of Carrying Out the Invention]

[0012]

In the light emitting device of this invention, it has an exciplex control layer between an anode plate and a luminous layer. The ingredient which carries out phosphorescence luminescence is the layer which exists independently, and a luminous layer is a layer which emits light even if it does not have an ingredient aiming at transition of energy like a host guest. Therefore, another object, for example, an ingredient with the operation which protects luminescent material from moisture or oxygen, for example, the inorganic-acid-ized compound of a calcium oxide, a metal like Mg, etc. may be contained in the luminous layer.

[0013]

An exciplex control layer is a layer for controlling generating of exciplex. the light which will come out from a component even if it emits light although it is thought that exciplex does not emit light in almost all cases -- the long wave from the luminescence wavelength (peak of λ_{max} and luminescence wavelength) of the luminescent material itself -- it is the light of the luminescence wavelength greatly shifted to the merit side. It can be said that generating of exciplex can be controlled because the difference of EL spectrum and PL spectrum is less than 10nm.

[0014]

The exciplex control layer is prepared between an anode plate and a luminous layer because the phosphorescence

luminescence metal coordination compound used by this invention is electronic transportability. Since exciplex is generated in the anode plate side of a luminous layer, the exciplex control layer is arranged between the anode plate and the luminous layer. The exciplex control layer may be arranged between the hole transporting bed and the luminous layer. Of course, a hole transporting bed is a layer arranged at the anode plate side, in view of a luminous layer. Moreover, a hole transporting bed can also serve as an exciplex control layer.

[0015]

It is desirable that the central metal of the phosphorescence luminescence metal coordination compound which constitutes a luminous layer is a rhenium at the point that electronic transportability is high. The metal coordination compound which uses a rhenium as a central metal has low LUMO level compared with other metal coordination compounds. Therefore, when using the high phosphorescence luminescence metallic compounds of electronic transportability used by this invention as a luminous layer, it is thought that the electron poured in from cathode reaches the anode plate side of a luminous layer easily.

[0016]

From such knowledge, this invention person etc. found out that it was desirable that the difference of the HOMO level of an exciplex control layer and the HOMO level of a luminous layer is set to 0.5eV or less, in order to control generating of exciplex. And in order to materialize such relation, it found out that it was required to set to -5.5eV or less HOMO level of a luminous layer which consists of a phosphorescence luminescence metal coordination compound. In addition, the minimum of the HOMO level of a luminous layer which consists of a phosphorescence luminescence metal coordination compound is 6.22eV. Normal luminescence of a phosphorescence luminescence metal coordination compound is no longer obtained in case of below this value.

[0017]

And in the light emitting device which fulfills these conditions, the phosphorescence light emitting device which sets the difference of EL spectrum and PL spectrum to less than 10nm and which a luminous layer becomes from a single ingredient can be offered.

[0018]

Next, the lamination of the light emitting device of this invention is explained. Drawing 1 is the cross section of 1 operation gestalt of this invention. the inside of drawing, and 1 -- for a hole transporting bed and 4, as for a substrate and 6, an anode plate and 5 are [cathode and 2 / a luminous layer and 3 / an electronic transporting bed and 8] exciplex control layers. In this operation gestalt, cathode 1 is a reflector, an anode plate 4 is a transparent electrode and a substrate 5 is a configuration of a transparence substrate. The configuration which uses cathode 1 as a transparent electrode, of course, and uses an anode plate 4 as a reflector may be used. In that case, the driver element for controlling burning of a light emitting device to a substrate especially, for example, a thin film transistor, (TFT) may be arranged. In that case, as the so-called top emission mold light emitting device, it is a desirable gestalt in the semantics of raising the numerical aperture of a luminescence side.

[0019]

In this Fig., although neither the electronic injection layer nor the hole impregnation layer is illustrated, you may prepare suitably. Or the gestalt in which neither the gestalt transposed to the electronic injection layer or the hole impregnation layer according to the individual or the electronic transporting bed 6 nor the hole transporting bed 3 nor an electronic injection layer nor a hole impregnation layer forms the electronic transporting bed 6 and the hole transporting bed 3, respectively, and the gestalt of these four layers which prepared any one or more layers suitably at least are sufficient.

[0020]

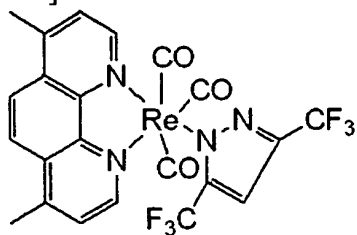
Moreover, one [at least] electrode of an anode plate 4 and cathode 1 may have multilayer composition.

[0021]

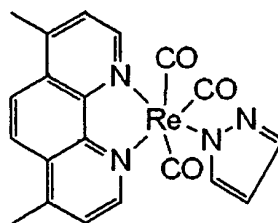
Although it said previously that it is desirable that a central metal is a rhenium as a phosphorescence luminescence metal coordination compound used by this invention, it illustrates below by making an example into a structure expression (Re (dmphen) (btpz), Re (dmphen) (pz)). Moreover, the structure expression of the compound used as an exciplex control layer is also illustrated below (TFB3, TFB4). Moreover, the structure expression of the compound used as a hole transporting bed or an electronic transporting bed is also illustrated below (floor line03, Bphen).

[0022]

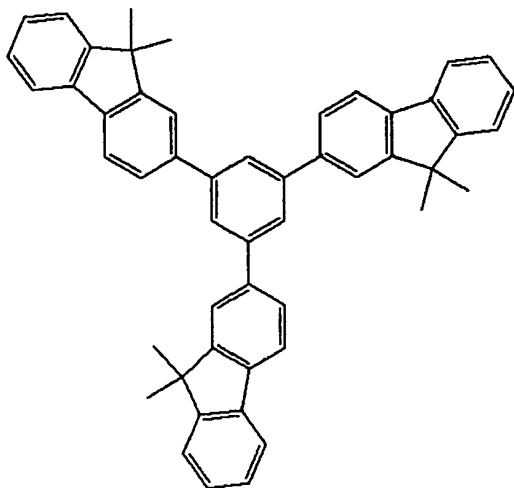
[Formula 1]



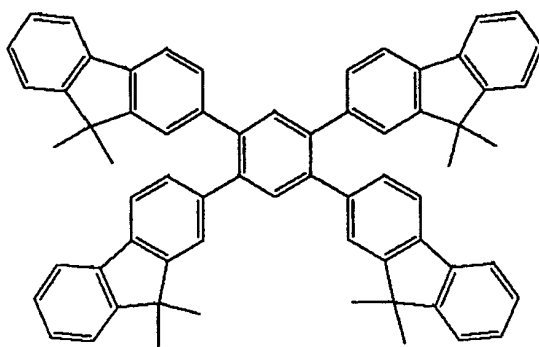
Re(dmphen)(btpz)



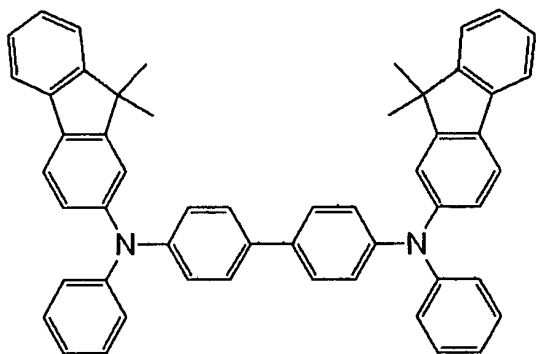
Re(dmphen)(pz)



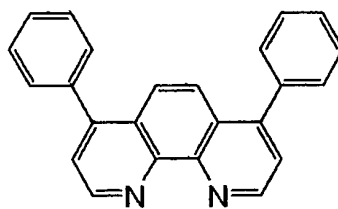
TFB3



TFB4



FL03



Bphen

[0023]

The light emitting device of this invention can be used for a display called a display. For example, it can use for the image display device used for the picture element part or the sub-picture element section of a display. Displays are the display carried in television, a personal computer, a digital camera, a camcorder, etc., a display carried in a car body. Moreover, the light emitting device of this invention may be used as the light source for lighting as the exposure light source to electrophotography-type a display or photo conductors, such as image formation equipment.

[0024]

The light emitting device of this invention may be used in a singular, or may be used by plurality. Light may be made to emit by two or more cases, for example, passive actuation, or active-matrix actuation. Moreover, when using two or more light emitting devices, monochrome or unique are sufficient as each. When unique, full color luminescence can be carried out.

[Example]

[0025]

(An example 1, an example 2, example 1 of a comparison)

On the substrate, the anode plate (ITO) whose thickness is 100nm was formed so that an electrode surface product might be set to 2 3nm. Each class formed on it and its thickness are as follows for every example and example of a comparison. In forming each component, continuation membrane formation by the vacuum deposition according each class to resistance heating was performed within the vacuum chamber of ten to 4 Pa to formation of the cathode which turns into a counterelectrode to an anode plate. In each example, each class is arranged on an anode plate at the indicated order.

[0026]

- Example 1

Exciplex control layer (25nm): TFB4

Luminous layer (40nm): Re (dmphen) (btpz)

Electronic transporting bed (60nm): Bphen

Metal-electrode 1(1nm): KF

Metal-electrode 2(150nm): aluminum

[0027]

- Example 2

Hole transporting bed (25nm): floor line03

Exciplex control layer (25nm): TFB3

Luminous layer (40nm): Re (dmphen) (btpz)

Electronic transporting bed (60nm): Bphen

Metal-electrode 1(1nm): KF

Metal-electrode 2(150nm): aluminum

[0028]

- The example 1 of a comparison

Hole transporting bed (40nm): floor line03

Luminous layer (40nm): Re (dmphen) (btpz)

Electronic transporting bed (60nm): Bphen

Metal-electrode 1(1nm): KF

Metal-electrode 2(150nm): aluminum

[0029]

The characterization of each component is shown in a table 1.

[0030]

[A table 1]

| | イキイ フロック 抑制層 | {1} HOMO (eV) | 発光層 (燐光発光性 金属配位化合物) | {2} HOMO (eV) | $\Delta E = \{1\}$ - {2} (eV) | cd/A (600cd/cm ²) | $T_{1/2}$ (h) | {3} $\Delta \lambda_{max}$ (nm) |
|------|--------------------|---------------------|---------------------------|---------------------|-------------------------------------|----------------------------------|------------------|---------------------------------------|
| 実施例1 | TFB4 | -5.72 | Re(dmphen) (btpz) | -5.78 | 0.06 | 7.5 | 50 | 5 |
| 実施例2 | TFB3 | -5.43 | Re(dmphen) (btpz) | -5.78 | 0.35 | 7 | 32 | 5 |
| 比較例1 | FL03 | -5.24 | Re(dmphen) (btpz) | -5.78 | 0.54 | 0.2 | 0.5 | 80 |

[0031]

[1] of a table 1 is the HOMO level of an exciplex control layer. measurement -- the Riken Keiki Co., Ltd. make -- AC-1 was used. A Measuring condition is among atmospheric air, and is a room temperature.

[0032]

Moreover, [2] is the HOMO level of a luminous layer (phosphorescence luminescence luminescence metal coordination compound). measurement -- the Riken Keiki Co., Ltd. make -- AC-1 was used. A Measuring condition is a room temperature in atmospheric air.

[0033]

Moreover, cd/A [600 cd/cm²] is the semantics of the current efficiency in brightness 600 cd/m². measurement of the amount of luminescence -- the product made from TOPCON -- BM-7 were used. A Measuring condition is a room temperature.

[0034]

Moreover, it is the semantics of the brightness half line at the time of low current actuation in T1/2(h). The brightness measuring device by the photodiode was used for measurement of a brightness half-life. A Measuring condition is a room temperature.

[0035]

Next, the difference of EL spectrum and PL spectrum was measured in each example and example of a comparison. A measuring device is a fluorometry machine made from HITACHI, and a Measuring condition is a room temperature. The result is shown in a table 1. Moreover, [3] shows the difference of λ_{max} of EL spectrum and PL spectrum.

[0036]

Consequently, the difference of EL spectrum and PL spectrum was able to be set to less than 10nm compared with the example 1 of a comparison, and the example 1 and the example 2 were able to obtain luminescence of the phosphorescence luminescence metal coordination compound origin. On the other hand, about the example 1 of a comparison, there are the following faults as compared with an example 1 and an example 2. That is, the difference of the HOMO level of floor line03 and Re (dmphen) (btpz) is 0.5eV or more, and since the phosphorescence luminescence metal coordination compound and exciplex of a luminous layer are formed, it is that brightness half line has become [current efficiency] low short.

[0037]

(An example 3, example 2 of a comparison)

On the substrate, the anode plate (ITO) whose thickness is 100nm was formed so that an electrode surface product might be set to 2 3nm. Each class formed on it and its thickness are as follows for every example and example of a comparison. In forming each component, continuation membrane formation by the vacuum deposition according each class to resistance heating was performed within the vacuum chamber of ten to 4 Pa to formation of the cathode which turns into a counterelectrode to an anode plate. In each example, each class is arranged on an anode plate at the indicated order.

[0038]

- Example 3

Exciplex control layer (25nm): TFB4

Luminous layer (40nm): Re (dmphen) (btpz)

Electronic transporting bed (60nm): Bphen

Metal-electrode 1(1nm): KF

Metal-electrode 2(150nm): aluminum

[0039]

- The example 2 of a comparison

Exciplex control layer (25nm): TFB4

Luminous layer (40nm): Re (dmphen) (pz)

Electronic transporting bed (60nm): Bphen

Metal-electrode 1(1nm): KF

Metal-electrode 2(150nm): aluminum

[0040]

The property result of each light emitting device is shown in a table 2.

[0041]

[A table 2]

| | エキサイ ブ・レックス 抑制層 | (1) HOMO (eV) | 発光層 (燐光発光性 金属配位化合物) | (2) HOMO (eV) | $\Delta E = (1) - (2)$ (eV) | cd/A (800cd/cm ²) | $T_{1/2}$ (h) | (3) $\Delta \lambda_{max}$ (nm) |
|------|-----------------------|---------------------|---------------------------|---------------------|--------------------------------|----------------------------------|------------------|---------------------------------------|
| 実施例3 | TFB4 | -5.72 | Re(dmpen) (btpz) | -5.78 | 0.08 | 7.5 | 50 | 5 |
| 比較例2 | TFB4 | -5.72 | Re(dmpen) (pz) | -5.34 | 0.48 | 0.3 | 0.2 | 55 |

[0042]

[1] of a table 1, [2], cd/A [@600 cd/cm²], and [3] are the same as that of a table 1.

[0043]

Consequently, it turns out that the example 3 is excellent in respect of current efficiency and brightness half line compared with the example 2 of a comparison.

[0044]

And the publication of a table 2 of [3] shows that the difference of EL spectrum and PL spectrum is set to less than 10nm only with a complex -5.5eV or less by HOMO level with a phosphorescence luminescence metal coordination compound.

[Brief Description of the Drawings]

[0045]

[Drawing 1] It is the cross section of 1 operation gestalt of the light emitting device of this invention.

[Description of Notations]

[0046]

1 Cathode

2 Luminous Layer

3 Hole Transporting Bed

4 Anode Plate

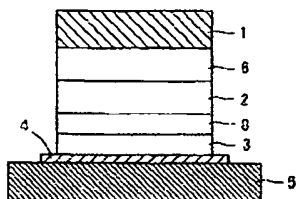
5 Substrate

6 Electronic Transporting Bed

8 Exciplex Control Layer

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Drawing selection 

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